DLA-93-P20047

INDUSTRIAL BASE PROGRAM ITEM SELECTION INDICATOR ANALYTICAL ENHANCEMENTS

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OPERATIONS RESEARCH AND ECONOMIC ANALYSIS OFFICE

DEPARTMENT OF DEFENSE
DEFENSE LOGISTICS AGENCY

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INDUSTRIAL BASE PROGRAM

ITEM SELECTION INDICATOR ANALYTICAL ENHANCEMENTS (DLA-93-P20047)

SECTOR SELECTION INDICATOR (SSI)

I. Objective

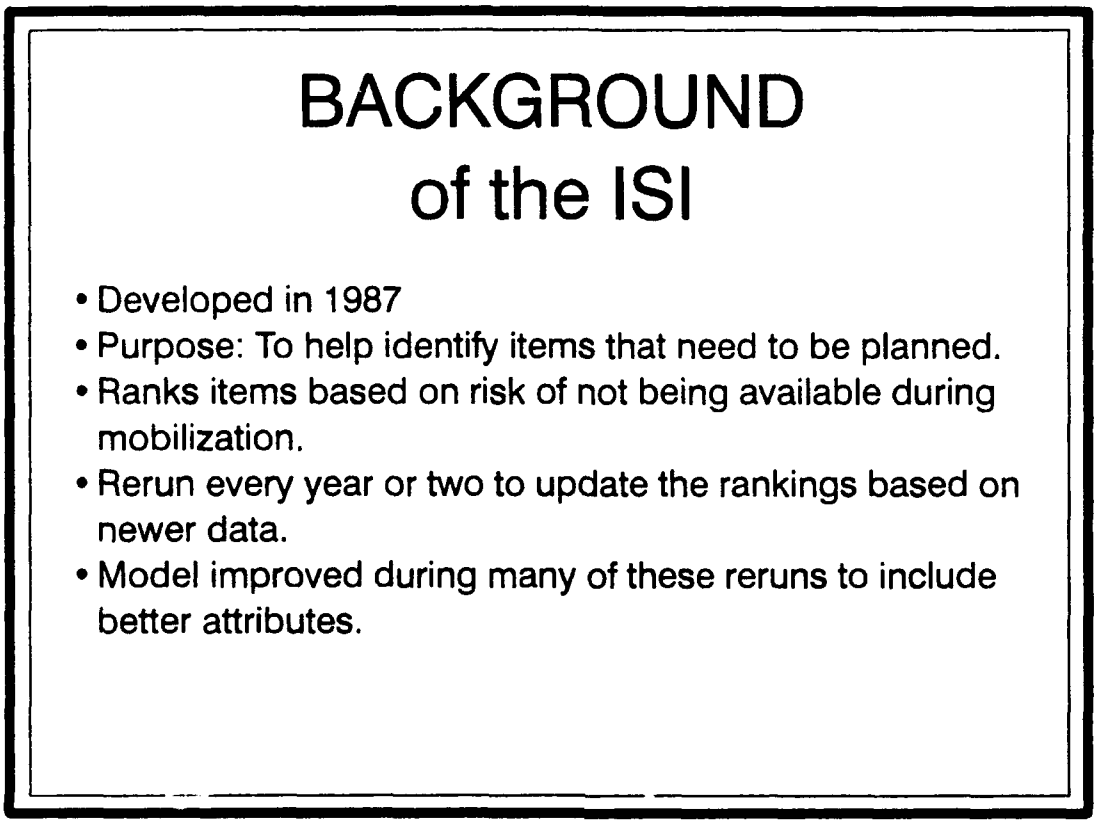
OBJECTIVE

DEVELOP A TOOL TO IDENTIFY AND RANK SECTORS OF THE INDUSTRIAL BASE AT GREATEST RISK

Industrial Base planning has traditionally focused on the item or NSN. This meant over 3 million items to plan. For all practical purposes this is impossible. Even deciding which items to plan first is no simple task. The result of this strategy was a good knowledge of a few items (less than 1%) and little understanding of the rest. The clear indication was that the way planning was done must change. It must be done at a different level, at the sector level. The new plan is to identify those sectors of the industrial base that are at greatest risk and plan these.

This change gives the planner something that is manageable. Instead of dealing with millions of items they are now dealing with hundreds of sectors. The task is still a difficult one. Picking sectors to plan is still extremely important because only a small number of sectors can be planned each year. To ensure that the most critical sectors are picked this project was started. The specific objective of this project is to develop a model that identifies and ranks sectors of the industrial base at greatest risk. This will be done by enhancing the Item Selection Indicator (ISI) to look at the sector level. This new tool will be called the Sector Selection Indicator (SSI).

II. Background



In 1987 DLA-DORO developed the Item Selection Indicator to help DLA manage the several million items under its control. This indicator was developed to help the Industrial Preparedness Program in their effort to develop mobilization plans with contractors for the production of critical materiel. The result was a tool that ranked each item according to the level of risk that the item would not be available in the needed quantity during a mobilization.

In order to identify which items should be planned first, criteria for what would indicate a critical item must be developed. Ideally we would like to find a single attribute which would separate all the items by risk. If we could say that lead time was the only important criteria, we could easily sort our database of items by leadtime and have a prioritized list. Ranking in a single attribute system is easy to do.

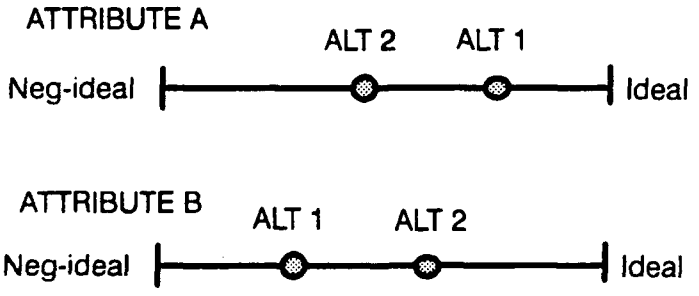
SINGLE ATTRIBUTE PROBLEM

- Evaluation of alternatives based on single criteria
- Ordering of alternatives is easy

Alternative 2 is clearly superior to Alternative 1

A single attribute or criteria is not enough. And when we go to even two attributes the question of which alternative should be ranked higher gets more difficult.

TWO ATTRIBUTE PROBLEM

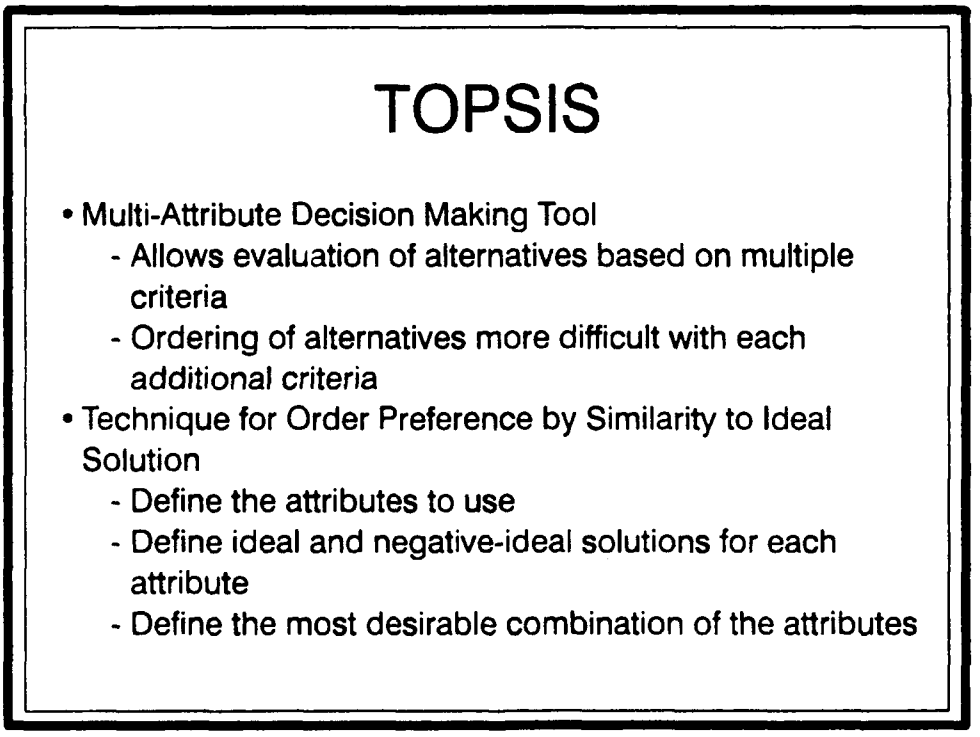


WHICH ALTERNATIVE IS SUPERIOR?

Previous to the introduction of the ISI model, IPP planners were using three attributes which they thought gave some indication of risk.

While the previous way of planning used multiple attributes, it could only look at them one at a time and then only in a logical yes/no format. The planner would look at each attribute. If it met the criteria it was kept. If it did not it was discarded from the list. The three attributes they used were leadtime (> 60 days), Other War Reserve Materiel Requirements (> $10,000) and mobilization demand ratio (> 3.0). This process was done for each of the items. This pared down the number of items from millions to thousands. This made things more manageable but was still more items than they could handle and gave no ranking of the remaining items. An example of the problem with this approach is that one item could have a lead time of 61 and a mobilization demand ratio of 3.0 and OWRMR of $10,000 and be on the list. Another item could have a lead time of 59, OWRMR value of $50,000 and a mobilization value of 10 and not be on the list. Clearly we would say the second item is at greater risk than the first but the first would be on the list.

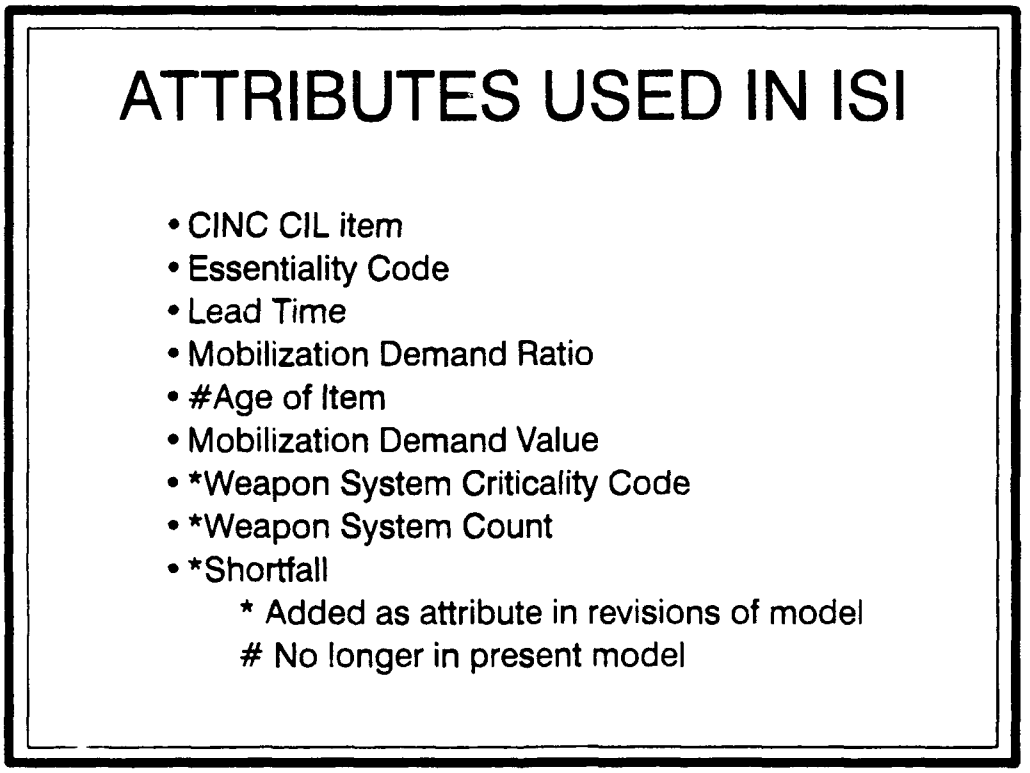
The method then should be able to include all of the attributes at once and take into account the relative differences between the criteria. The tool that would allow this was the multi-attribute decision making technique called TOPSIS (Technique for Order Preference by Similarity to Ideal Solution).



There are three basic steps before the TOPSIS model can be run. First we must define the attribute which we will use. Second we must define the most desirable solution (ideal solution) and the least desirable solution (negative ideal) for each attribute. Third we must define the most desirable combination of the attributes. We combine the attributes so the total is 100%. If we

have four attributes and Attribute # 1 is more important, we might give it 40% and the other three 20% each. This allows us to emphasize the attributes we deem most important.

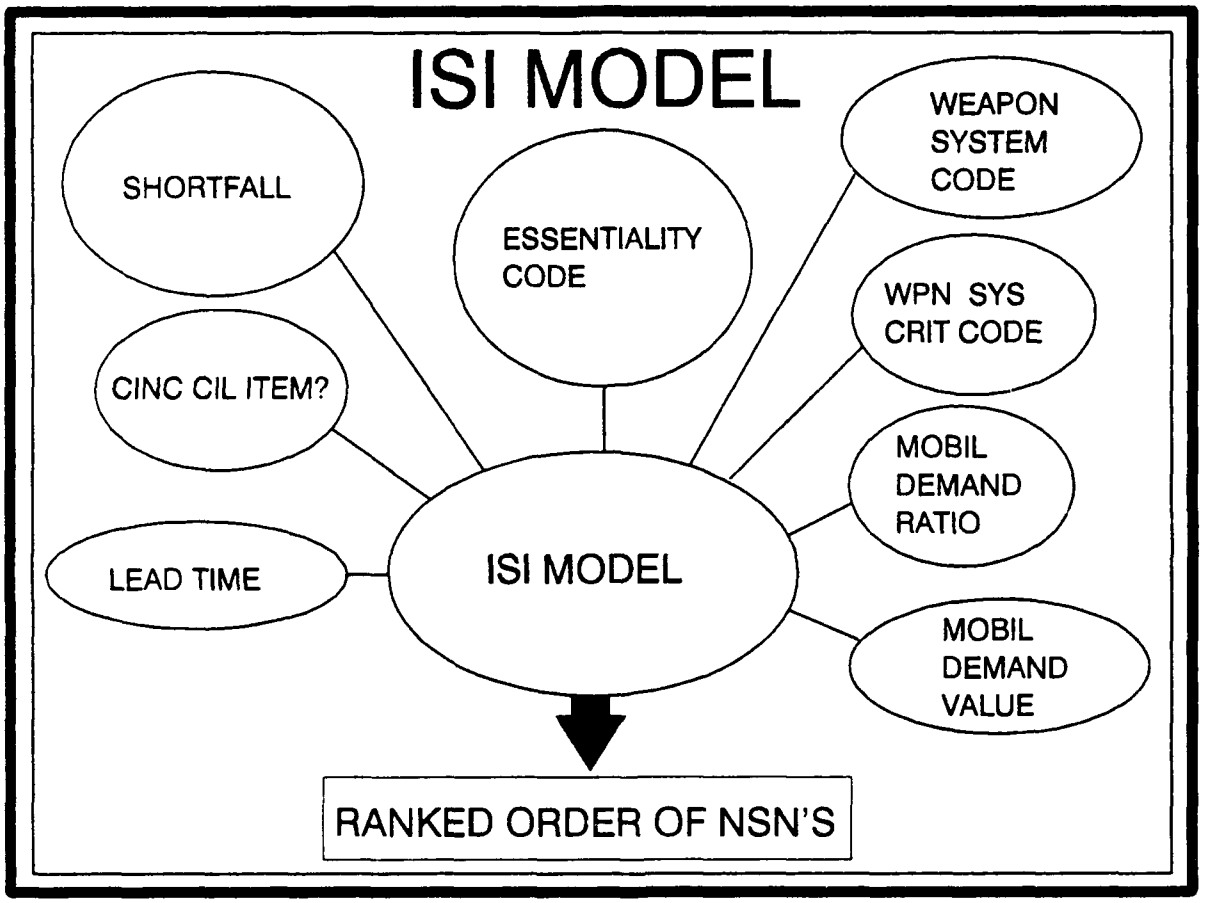
The attributes chosen were based on item characteristics which represented either the criticality or the availability of an item. If there is no U.S. source for the item or U.S. manufacturers cannot supply the required quantity, this item would be a logical choice for planning.



The attributes chosen were (1) Critical Items List Application - Is the item on the Commander-in-Chief Critical Items List (CINC CIL)? (2) Essentiality Code - which represents the importance of an item to a weapon system (3) Lead Time - length of time required to produce an item. The greater the lead time, the slower the expected response to demands. (4) Mobilization Demand Ratio - ratio of the mobilization demand requirements to normal peacetime demand. If the ratio is large, the potential for insufficient production base capabilities is greater. (5) Age of Item - an established item's availability is more certain than a new item (6) Mobilization Demand Value - Projected dollar value of the mobilization demand (Other War Reserve Materiel Requirements).

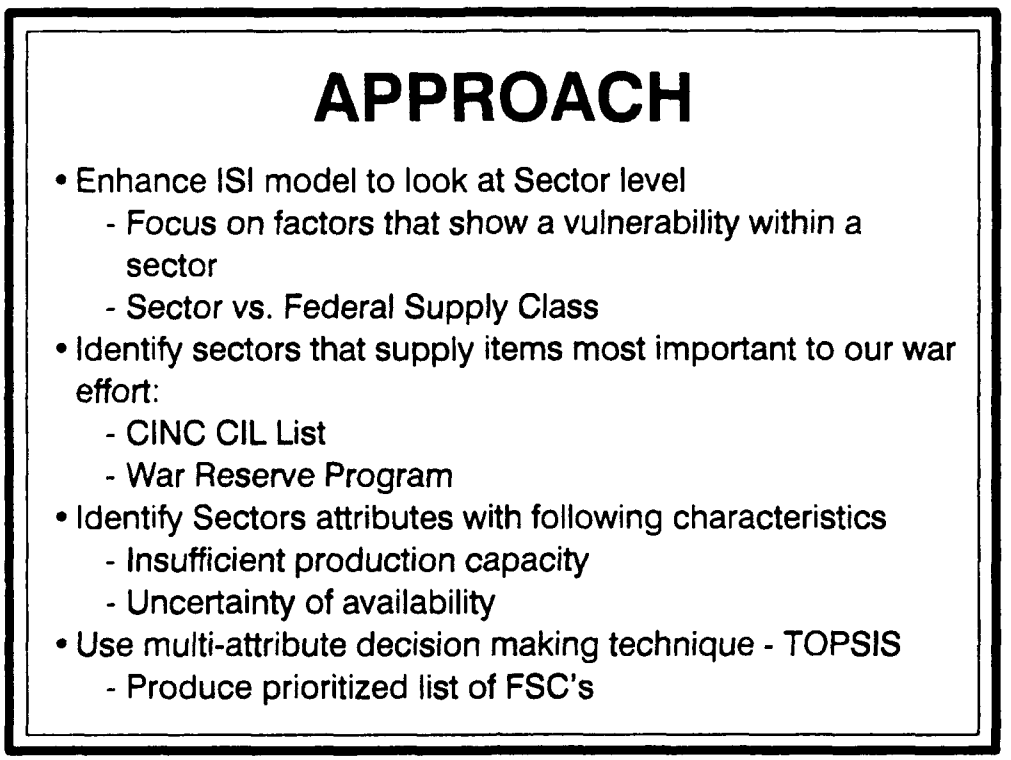
Since 1987 this indicator has been revised and rerun several times. As the model has been refined some new attributes have been added and some have been deleted. We have eliminated Age of Item as an attribute. We have added three new attributes. They

are (1) Weapon System Criticality Code - Does the item support critical weapon systems? (2) Weapon system count - Does the item support few or many weapon systems. (3) Shortfall - Do we have in stock now the needed number of an item to meet mobilization demand



TOPSIS then takes the different attributes and the weightings given to each one and calculates how close this particular item is to the negative ideal solution. The one which has the closest distance to the negative ideal solution would be the one we would want to plan first.

III. Approach



While the task of trying to plan every item is almost impossible, the item selection indicator has shown itself to be a very useful management tool. It gives useful information and ranks the items so scarce resources can be directed on the most urgent items. When we look at sectors, we must still ask the same question. With limited resources what sectors should I look at first? To answer this question we will build on our experience with the ISI model and enhance it to look at sectors.

A sector is usually defined in terms of the Commerce Department's industry codes. However DLA does not have an automated ability to define its items in these terms. Therefore when we use the term sector we are thinking in terms of Federal Supply Class (FSC). This breakdown works well for most of the FSCs. However some FSCs may include more than one industrial group.

The approach we will use then can be broken into three steps. (1) Identify sectors that supply items most important to our war effort. (2) Identify sector attributes with characteristics that show a problem in meeting this demand. These would include sectors where there is insufficient production capacity and an uncertainty of availability. (3) Finally we would use a multi-attribute decision making technique (TOPSIS) to produce a prioritized list of FSC's. Part of this step would include assigning the weights each attribute would receive in the model.

IV. Analysis

The steps to be taken to run the model are: (A) Identification of the Sectors to examine (B) Selection of Attributes (C) Weighting of the attributes (D) Computation of Indicator Values

A. Identification of Sectors to Examine. Sectors were limited to those which had items which were on the Service War Reserve list or on the CINC CIL. This concentrates on those areas considered most essential for planning. Since the ISI scores were used in the model and they use the same items we made sure we had a common bond so that all six attributes of data would be available for computing scores.

B. Selection of Attributes. Planning should be focused on those sectors (1) which produce items most important in our war effort (2) which have the greatest likelihood of unavailability of products or inability to meet production capacity. Based on this criteria the following attributes were chosen in consultation with representatives of DLA-PRS. All these attributes were considered to have met this criteria and data on them was thought to be available.

ATTRIBUTES IN SSI MODEL

1. Item Selection Indicator - FSC average of individual ISI scores
2. Backorder Total Dollar - Total dollar value of items in each FSC backordered
3. Backorder Total Quantity - Total quantity of items in each FSC backordered
4. Vendor Base - Average # of proven manufacturers per NSN in the FSC

1. Item Selection Indicator. This is the FSC average of the individual ISI scores. If individual items are scored high in terms of needs for planning, this is an indication that the FSC should be looked at carefully. Using this attribute will focus on those

items and in turn sectors which we find on the CINC CIL and WAR Reserve list.

2. Backorder Total Dollar. This looks at the total dollar value of backorders at present for the FSC. This was chosen because it can show possible production problems in the FSC. If the sector cannot keep pace with demand during peacetime, it should be considered vulnerable during mobilization.

3. Backorder Total Quantity. This looks at the total quantity of items in each FSC that are backordered. This attribute shows possible production problems for sectors that may not have high value items.

4. Vendor Base. The number of proven manufacturers in a sector. We look at the average number of manufacturers per item. While a limited number of manufacturers may be able to handle peacetime demand, a stronger base of manufacturers will be needed to handle the increased demand during mobilization. A low average may mean that the base is not sufficient to met the demand.

ATTRIBUTES IN SSI MODEL (Cont)

5. DLA Vendor Rating System - Performance of a vendor based on his delivery and quality ratings.
6. Desert Storm Total Dollar - Total dollar value of requisitions made specifically for Desert Storm
7. Desert Storm Total Quantity - Total quantity of items ordered specifically for Desert Storm
8. Foreign Dependency - Rating of the dependency of a FSC on foreign parts or production

5. DLA Vendor Rating Score. These are the scores from DLA's Vendor Rating System. The vendor's score is based upon delivery and quality. Delivery is based upon % on time delivery and average days late.

Quality is based upon product complaints, packaging complaints and results of lab tests. While the vendor base may be large, if they are not high quality producers it may indicate possible problems.

6. Desert Storm Dollar Value. This looks at the total dollar value of requisitions made for Desert Storm for each FSC. This gives an indication in an actual war time scenario what areas may be hit the most. These should certainly be a priority for planning.

7. Desert Storm Quantity Totals. This looks at the total quantity of items ordered for Desert Storm. This accounts for items needed in greater quantity which may or may not cost much.

8. Foreign Dependency. This is a rating of dependency of a particular FSC to foreign parts or production. If the production base for certain key items is in another country we are at risk. This rating can help determine where we need to encourage domestic production capability for critical items.

C. Running the TOPSIS SSI Model

1. Definition of ideal and Negative-ideal values. While ideal and negative-ideal solutions were obvious for some indicators, others were more difficult to calculate. The goal was to identify limits which gave a fair representation of the range of the values without allowing extreme values in one or two sectors to limit the influence of a certain attribute for all the other sectors. The following values were assigned based on statistical analysis of the data. Note that each center was done separately. This was necessary because of the wide range in values between centers. This will give a more accurate reflection of the relative ranking within each center. It will mean that a comparison between centers would be of no value.

		Ideal	Neg-Ideal
Item Selection Indicator		0.00	1.00
Backorder Total Dollar	C	0	5,000,000
	E	0	4,300,000
	G	0	2,800,000
	I	0	8,700,000
Backorder Total Quantity	C	0	175,000
	E	0	75,000
	G	0	150,000
	I	0	5,000,000
Vendor Base		2.00	1.00
DLA Vendor Rating Score		100.0	0.00
Desert Storm Dollar Value	C	0	240,000
	E	0	150,000
	G	0	170,000
	I	0	320,000
Desert Storm Qty Value	C	0	5,000
	E	0	2,000
	G	0	4,000
	I	0	50,000
Foreign Dependency		0	5

2. Clipping of extreme values. Sectors which had attributes beyond the bounds of the ideal or negative-ideal values were clipped to these limits.

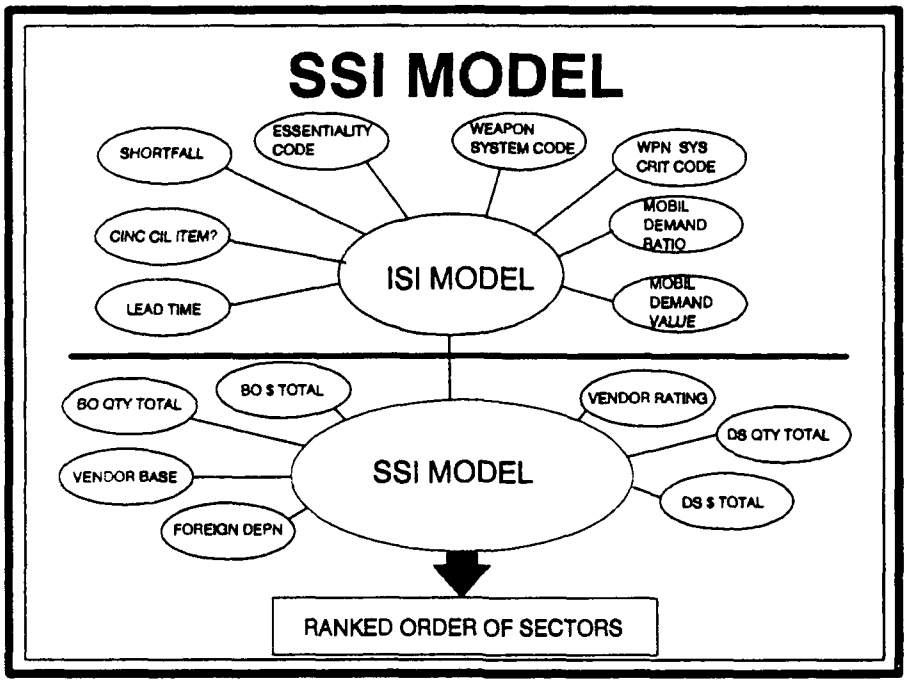
3. Normalization of attributes. Each of these attributes were normalized to produce an attribute value range of 0 to 1.

4. Application of attribute weights. The normalized attribute values were multiplied by the weighting factors.

5. Computation of distance measures. The Euclidean distances to both the ideal and negative-ideal solutions were calculated.

6. Computation of Indicator value. The relative closeness of each sector to the ideal solution was computed by dividing the distance to the negative-ideal by the sum of the distance to the ideal and negative-ideal solutions.. This result is subtracted from one to give an indicator where a higher value (closest to 1.00) indicates a greater need for planning.

D. Indicator Adjustments. The results can be fine tuned by adjusting (1) the ideal and negative-ideal weights (2) the weighting given to each attribute.



V. Discussion

DISCUSSION/RESULTS

- Limitation of Data Availability
  - DLA Vendor Rating Scores - Based on Delivery scores only. Quality data not available at this time.
  - Foreign Dependency - Not available at this time.
- Model run for two different weighting schemes
- Results show dependence on weighting factors
- Number of FSC's ranked for each center
  - Construction - 78
  - Electronic - 59
  - General - 111
  - Industrial - 36

A. Limitations of Data Availability. The model attributes were chosen because they represented the truest

indicators of sector need and because we thought data would be available. However some the data (scores) which come from other ongoing projects is not completely available.

1. DLA Vendor Rating Score. The vendor score is based upon quality and delivery scores. At this time delivery data is available but quality data is not available. The model used the available delivery scores and should incorporate the quality scores when they become available. This will probably be towards the end of this calendar year.

2. Foreign dependency. A model to rank sectors on the degree of foreign dependence is in the testing phase now. If it is deemed acceptable these results could be incorporated into the model later this year. At present the model does not use foreign dependency in its calculation.

B. The model was run using two different weightings as supplied by representatives of DLA-PRS. The results show a difference reflecting the weightings used. It points to a need for the users of the model to be able to run different scenarios and compare outputs to fine tune the model for their situation. In its present form, the model is on a mainframe computer at DORO. Rerunning the model is easy but getting the results to the centers slows the process.

VI. Future Enhancements

FUTURE ENHANCEMENTS

- Vendor Base - Incorporate base of manufacturers who bid but may not have received contracts.
- Integration with ISI Model - Develop dBase IV model that allows user to look at FSC level and also NSN level within that FSC.
- User friendly computer program of SSI Model - Allows users to run model changing attribute values.

A. Vendor Base. We now look only at proven manufacturers based on completed contracts with them. Completion of DLA Vendor Rating System may allow access to data on bidders as well the awardee. This may give a truer indication of the real base for the item/sector.

B. Integration with ISI Model in a user friendly Dbase IV model. Allowing the user to look at the big picture and specifics at the same time. Allows the user to look at high risk sector and then with punch of the key look at specific items within that sector that are high risk. It will allow planners, while looking at specific items, to have information on the status of the sector it is in.

C. User friendly personal computer program of the SSI model. The model is on a mainframe computer at DORO. It is not easy for the users to get the information or to try "what if" scenarios. A PC program could be written that allows the users to change the weightings and get the new results at their desk. This would give them better information and allow them to use this model more effectively.

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13. ABSTRACT *(Maximum 200 words)*

The purpose of this project was to enhance the Item Selection Indicator (ISI) model and adapt it for use on sector studies. The project resulted in a Sector Selection Indicator (SSI) model which builds on the ISI model. The SSI prioritizes industrial sectors for further study based on aggregate ISI values, Operation Desert Storm demand data, backorders, depth of vendor base, degree of foreign dependence, and a number of other critical factors. The model can be used to prioritize federal supply classes at each Defense Logistics Agency Supply Center for in-depth analysis.

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